F 1332.15 (5-88)

U.S. DEPARTMENT OF ENERGY

OMB Control No. 1910—1400

DOE AND MAJOR CONTRACTOR RECOMMENDATIONS FOR ANNOUNCEMENT AND DISTRIBUTION OF DOCUMENTS

DOE Report No.	2. DOE Contract No.	3. DOE B and R code(s)	4. OSTI UC or C Category No.
SAND88-1719C			

Title: Target Nonhomogeneity and Effect on EPW Design

Type of Document ("x" one)

a. Scientific and technical report: ☐ monthly ☐ quarterly ☐ annual ☐ final ☐ topical ☐ other

b. Conference paper: Name of conference (no abbreviations) AIAA Missile Systems - Missile Sciences Conference

Location (city/st/ctry) Monterey, CA

Date (mo/day/yr) 11/28-12/1/88 Sponsor AIAA

Contents: ☐ proceedings ☒ viewgraphs ☐ paper ☐ poster sessions

c. Computer Media:

Document is accompanied by ☐ magnetic tape(s) ☐ diskette(s) ☐ other (specify)

d. Other (e.g., journal article, manuscript, manual, etc.) (specify)

Copies Transmitted to OSTI ("x" one or more)

☐ a. Copies transmitted for unclassified distribution.
☐ b. Copies transmitted for special distribution.
☒ c. Two reproducible copies transmitted.
☐ d. Ten copies transmitted for OSTI processing and NTIS sales.
☐ e. Copies transmitted for classified distribution as defined in M-3679.
☐ f. One copy transmitted for OSTI classified processing.

Document contains information pertaining to any of the following:

☒ Yes ("x" one or more) ☒ No (if no, unlimited distribution may be made within the U.S. In addition, copies may be made available to Foreign requestors through exchange agreements or NTIS sales.)

☐ a. Classified (Announce to addresses in M-3679)
☒ b. Official Use Only (OUO)
☐ c. Export Control/ITAR/EAR
☐ d. Proprietary Information
☐ e. Small Business Innovation Research (SBIR)
☐ f. Unclassified Controlled Nuclear Information (UCNI)
☐ g. Patent Sensitivity
☐ h. Translations of copyrighted material (Boxes b–h will be announced to Government agencies and their contractors)
☐ i. Other (explain) (This designation must be in accordance with written DOE Program Office guidance)

Upon demand, OSTI will make distribution of these documents in accordance with existing laws, regulations, and/or written program office guidance.

. Patent and Copyrighted Information

a. ("x" one) ☒ 1. DOE patent clearance has been granted by responsible DOE patent group.
☐ 2. Document has been sent to responsible DOE patent group for clearance.
☐ 3. Patent clearance not required.

b. Does this material contain copyrighted information? ☐ No ☐ Yes
If yes, has release been obtained for DOE reproduction? ☐ No ☐ Yes (attach release)

0. Additional information, remarks, and special handling instructions. (*Do not* identify Sigma categories for Nuclear Weapon Data reports, and *do not* provide additional instructions which are inconsistent with item 8 above.) (Continue on separate sheet, f necessary)

11. Submitted by (Name and Position) (Please print or type)		Phone
W. I. Klein, Supv., Div 3151		(505) 844-8808
(Organization) Sandia National Laboratories	Signature J. Aglesinger for	Date 11/23/88

EPW DESIGN CONSIDERATIONS

- PAYLOAD

  NUCLEAR VS. CONVENTIONAL, SIZE, ETC.

- DELIVERY SYSTEM CONSTRAINTS

  WEIGHT, DIAMETER, LENGTH, C.G.

- IMPACT CONDITIONS

  VELOCITY, ANGLE OF ATTACK (AOA), IMPACT ANGLE

- TARGET CONDITIONS

TYPICAL TARGET DESCRIPTION

- Target Set
  - Point or area targets? Number?
  - Well characterized?
- Soil - Detailed description not usually necessary
  - Layering, type, strength, water content, density, frozen, etc.
- Concrete
  - Strength, rebar, thickness, boundary conditions
- Rock
  - Given
    - Type, strength, density, water content
  - Needed
    - Weathering, cracks, fissures, bedding planes, etc.

EVALUATE EFFECT OF ASSUMING HOMOGENEITY
TYPICAL ANALYSIS

SOIL

- AXIAL - CAN BE HANDLED ANALYTICALLY
- LATERAL LOADING - NO SIGNIFICANT EFFECT

CONCRETE

- AS AN ENGINEERING MATERIAL
  - * EFFECTS OF REBAR, AGGREGATE, STRENGTH VS. THICKNESS VARIATIONS - RELATIVELY UNIMPORTANT
- AS A TARGET
  - * EDGE EFFECTS - MAJOR IMPORTANCE TO LATERAL AND AXIAL LOADS
  - * SOIL OVER OR UNDER - SECONDARY IMPORTANCE
  - * RUBBLE - IMPORTANT TO LATERAL LOADS

ROCK - PROPERTIES TAKEN FROM INTACT SAMPLES

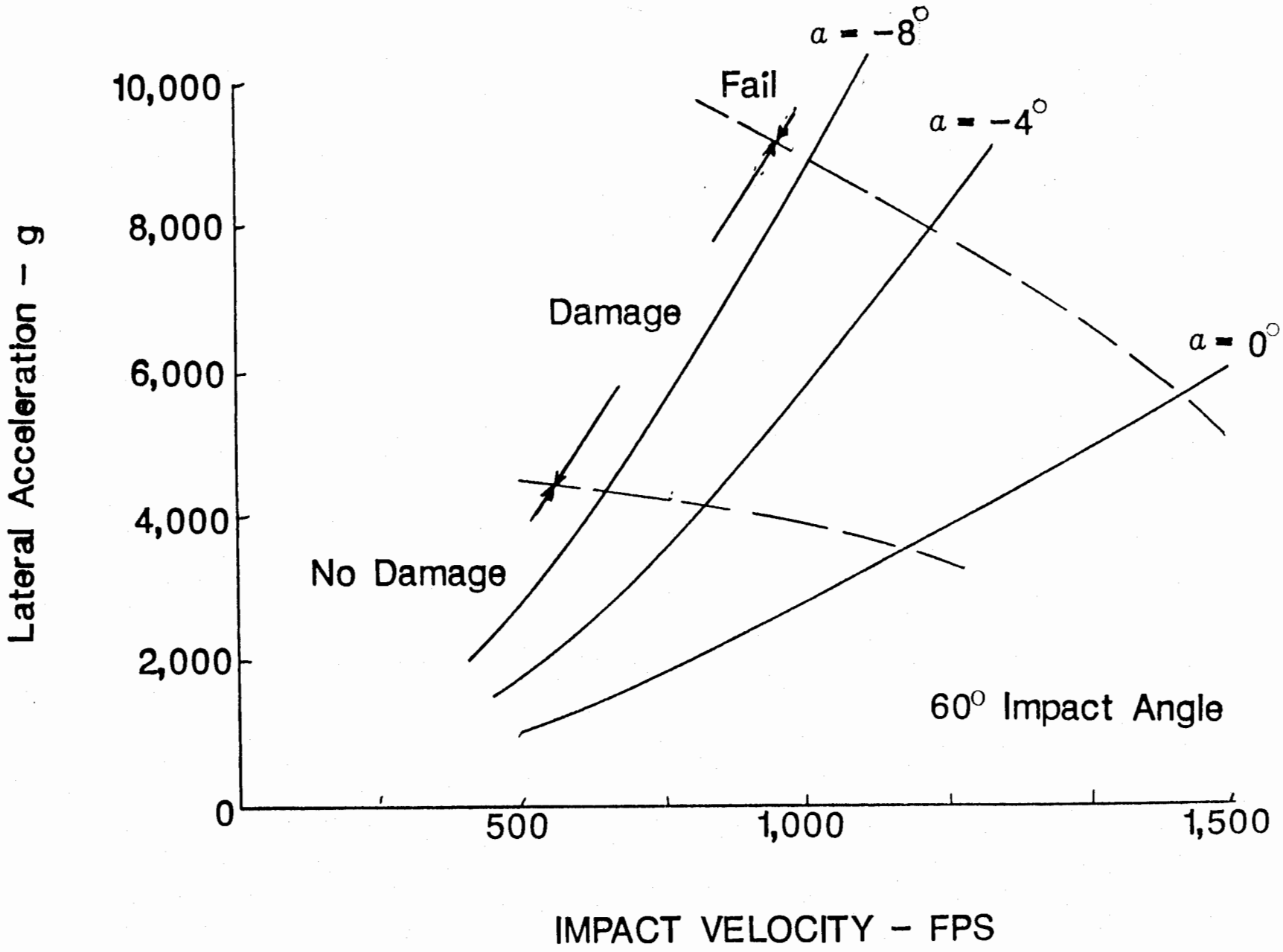
- * AXIAL LOADS - CONSERVATIVE APPROACH
- * LATERAL LOADS - VERY NON-CONSERVATIVE

DATA BASE

D-BASE III: OVER 800 SELECTED DATA POINTS

- SEARCHED FOR
  - * ROCK
  - * NO ANGLE OF ATTACK
  - * NORMAL IMPACT
- LOCATED 51 TESTS
  - * THESE SHOULD HAVE HAD NO LATERAL LOADING
  - * 21 OF THESE WERE BENT DUE TO LATERAL LOADING
- CONCLUSION
  - * 40% OF OUR EPW'S ARE DAMAGED DUE TO TARGET NONHOMOGENEITY
  - * METHOD OF ANALYSIS IS NEEDED

EXAMPLE OF COMBINED EFFECTS OF AOA AND IMPACT ANGLE



DETERMINATION OF EQUIVALENT AOA

- USING SAMPLL CODE, DETERMINE AOA NECESSARY TO DAMAGE ROCK PENETRATORS AS NOTED IN OUR DATA BASE

- THE TYPICAL EQUIVALENT AOA WAS DETERMINED TO BE 4°

- BASED ON TRAJECTORY DATA IN ROCK, IT WAS ALSO NOTED THAT
  - THE EQUIVALENT AOA CONCEPT APPEARS REASONABLE
  - THE AFFECTS OF NONHOMOGENEITY ARE INDEED VERY RANDOM

ASSUMPTIONS FOR A "WORST CASE" ANALYSIS

- USE WORST CASE IMPACT ANGLE
- ASSUME AOA IS ADDITIVE EFFECT TO IMPACT ANGLE
- ASSUME EQUIVALENT AOA (NONHOMOGENEITY) TO ALSO BE ADDITIVE

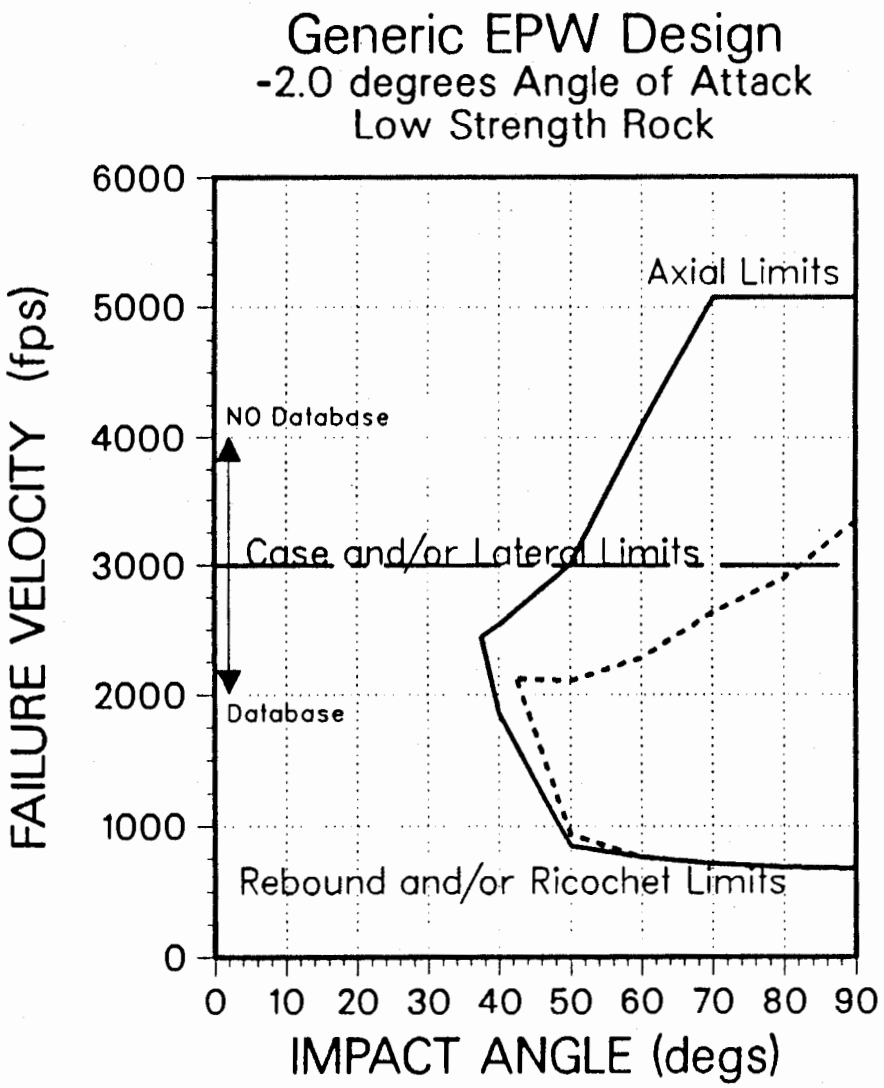
POSSIBLE CONCLUSIONS

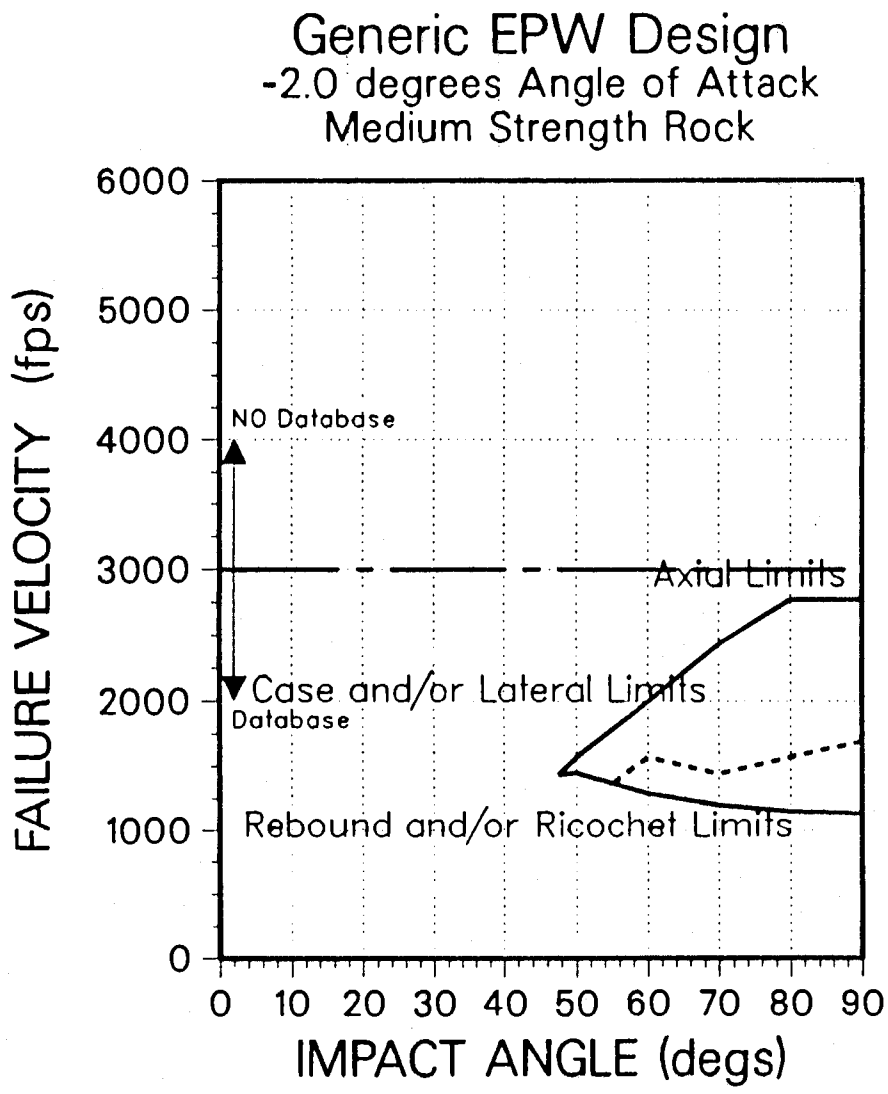
1. IF YOU CAN SURVIVE ABOVE ASSUMPTIONS, THE DESIGN IS ADEQUATE FOR MOST CONDITIONS
2. IF THE DESIGN IS NOT ADEQUATE FOR THE ABOVE ASSUMPTIONS, A STATISTICAL ANALYSIS WILL BE NECESSARY

STATISTICALLY BASED DESIGN

- USE REALISTIC VALUES FOR VARIATION OF EACH INPUT PARAMETER
- CALCULATE P_K FOR EACH TARGET
- SELECT NUMBER OF WEAPONS REQUIRED TO GIVE DESIRED P_K

NOTE: THIS TYPE ANALYSIS IS OF MORE USE TO THE WEAPONEER, EVEN THOUGH IT CAN BE USEFUL AS A DESIGN TOOL


Generic EPW Design
-2.0 degrees Angle of Attack
Low Strength Rock
FAILURE VELOCITY (fps)
6000
5000
4000
3000
2000
1000
0
Axial Limits
NO Database
Case and/or Lateral Limits
Database
Rebound and/or Ricochet Limits
0 10 20 30 40 50 60 70 80 90
IMPACT ANGLE (degs)


Generic EPW Design
-2.0 degrees Angle of Attack
Medium Strength Rock
FAILURE VELOCITY (fps)
6000
5000
4000
3000
2000
1000
0
NO Database
Axial Limits
Case and/or Lateral Limits
Database
Rebound and/or Ricochet Limits
0 10 20 30 40 50 60 70 80 90
IMPACT ANGLE (degs)